Missouri Department of Natural Resources

Biological Assessment Report

Miami Creek
Bates County

December 15, 2004

Prepared for:

Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Protection Program
Water Pollution Branch

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Air and Land Protection Division
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1.0 Introduction

At the request of the Water Protection Program (**WPP**), the Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Miami Creek, which flows through mostly rural portions of Bates County, Missouri. A total of 18 miles of Miami Creek was added to the 303(d) list of impaired waters in 1998 due to sediment resulting from agricultural non-point source pollution.

To document any changes in the macroinvertebrate reference community that may have resulted from extended drought conditions in western Missouri prior to the fall sampling season, Little Drywood Creek, a biological criteria reference stream, was sampled in fall 2003. Because no spring 2004 samples were collected from Little Drywood Creek, data from previous years were used for comparison. This comparison was to determine whether a biological impairment exists in a system that has been listed impaired due to increased sediment input. Sampling at Miami Creek was conducted on September 16-17, 2003 and on March 16-17, 2004 to provide data to the WPP for use in evaluating and comparing the biological integrity of the two streams. Dave Michaelson, Ken Lister, and Randy Sarver of the Environmental Services Program, Air and Land Protection Division conducted the sampling.

On August 13, 2003 a study plan was submitted to the WPP (Appendix A). A total of three null hypotheses were stated in the plan:

1) Macroinvertebrate assemblages will not differ among reaches of Miami Creek from upstream to downstream;

2) Water chemistry will not differ among reaches of Miami Creek from upstream to downstream;

3) The macroinvertebrate assemblage of Miami Creek will not differ from that found in biological criteria reference streams.

2.0 Study Area

The Miami Creek watershed originates in northwestern Bates County, near the town of Merwin, Missouri and flows southeast to its confluence with the Marais des Cygnes River east of Rich Hill, Missouri. The 250 square mile watershed is mostly rural, dominated by pasture, cropland, and woodlands. See Table 1 for a comparison of land use for Miami Creek, the Plains/Osage Ecological Drainage Unit (**EDU**), and the biocriteria reference streams used in this study.

The mainstem Miami Creek is approximately 40 miles long and enters the Marais des Cygnes River at River Mile 22.7 (Dent et al. 1998). A pilot channel was dug in the early 1900s in an attempt to relocate the lower 4.5 miles of Miami Creek to a 5.7 mile long

Miami Ditch (Appendix B, map 1). Currently, the base of the Miami Ditch pilot channel, which begins approximately 150 feet east of the northbound lane of Highway 71, is

Table 1
Percent Land Cover

	Urban	Crops	Grassland	Forest	Swamp/ Marsh
Plains/Osage EDU	0.2	23.0	54.9	17.9	0.3
Miami Creek*	0.4	22.7	65.8	10.2	0.0
EF Crooked River	0.1	67.1	22.3	8.5	0.0
Little Drywood #1	1.3	13.9	62.7	19.7	0.0
Little Drywood #2	0.2	16.2	62.4	20.0	0.0
Little Drywood #3	0.0	19.1	60.9	18.8	0.0

*Includes entire watershed--i.e. Miami Creek and each of its sub-watersheds

nearly the same elevation as the normal high water bank of Miami Creek (Appendix C, photograph 1). We observed runoff surface water flowing northwest from the ditch into Miami Creek, demonstrating that the elevation of Miami Ditch remains higher than Miami Creek. In addition, it appears that the original course of the upper several hundred feet of Miami Ditch was diverted--perhaps during the construction of Highway 71--such that the uppermost portion of the ditch lies parallel to the highway, rather than in a position to capture the flow of Miami Creek (Appendix C, photograph 2). As a result, the main flow of Miami Creek would have to make a sharp angular turn to enter Miami Ditch. These factors may explain why Miami Ditch has yet to become the primary channel. Should the ditch capture Miami Creek, it would increase the overall length of Miami Creek by approximately 1.5 miles and relocate its mouth approximately nine river miles downstream on the original Marais des Cygnes channel to River Mile 13.8 (Dent et al. 1998).

It is important to note that, at this time, the lower portion of Miami Ditch also has failed to capture the flow of Miami Creek. Several maps of the area as well as GIS data layers and studies conducted on the West Osage River Basin (e.g. Dent et al. 1998) indicate that the lower portion of Miami Creek flows into the ditch, resulting in lengthening of the channel and relocation of the confluence with the Marais des Cygnes River, mentioned above. We observed the ditch at the lower intersection with Miami Creek (Appendix B, map 2) to be a relatively small channel (Appendix C, photographs 3 and 4), with Miami Creek maintaining its original course. Currently, the 303(d) list includes an 18-mile reach of Miami Creek based on the assumption that the lower portion of the system is carried by Miami Ditch. Given that Miami Creek continues to flow in its original channel, the length of the listed reach should be reduced from 18 to 16.5 miles.

Although several small streams empty into Miami Ditch downstream from its lower intersection with Miami Creek, the largest contributor is Double Branch, a fifth-order tributary that enters Miami Ditch approximately 1.3 miles upstream of a loop of the

Marais des Cygnes River that has been bypassed via channelization (Appendix B, map 2). Because Double Branch is roughly similar in size to Miami Creek, it would be possible to mistake the water in Miami Ditch entering at Marais des Cygnes River mile 13.8 to be that of redirected Miami Creek.

Miami Creek is located in the Plains/Osage EDU. An EDU is a region in which biological communities and habitat conditions can be expected to be similar. Please see Appendix B, map 3 for a display of the EDU and the two 11-digit Hydrologic Units (**HU**), 10290102120 and 10290102130, which comprise the Miami Creek watershed. Each of the Miami Creek sample stations fall in a reach designated class "P" with beneficial use designations of "livestock and wildlife watering" and "protection of warm water aquatic life and human health--fish consumption."

3.0 Site Descriptions

All Miami Creek sample stations were located in Bates County, Missouri. The average width and discharge measurements during the survey period are given for each sampling station in Table 2 in the Data Results section.

Miami Creek #1 (sec. 15, T. 39 N., R. 31 W.) was located downstream of the bridge on an unnamed county road. Geographic coordinates at the upstream terminus of this location were Lat. 38.16188261º, Long. -94.32898615º.

Miami Creek #2 (SE ¼ sec. 8, T. 39 N., R. 31 W.) was located downstream of the Highway 71 bridge. Geographic coordinates at the upstream terminus of this location were Lat. 38.17689826º, Long. -94.35283554º.

Miami Creek #3 (NW ¼ sec. 6, T. 39 N., R. 31 W.) was located downstream of the bridge on an unnamed county road. Geographic coordinates at the upstream terminus of this location were Lat. 38.22134601º, Long. -94.38044350º.

Miami Creek #4 (SE ¼ sec. 24, T. 40 N., R. 32 W.) was located downstream of the Highway 52 bridge. Geographic coordinates at the upstream terminus of this location were Lat. 38.25830019º, Long. -94.40572601º.

Miami Creek #5 (NE ¼ sec. 14, T. 40 N., R. 32 W.) was located east of Butler City Lake. Geographic coordinates at the upstream terminus of this location, the point at which the Butler City Lake spillway joins Miami Creek, were Lat. 38.27964293º, Long. -94.42603314º.

4.0 Methods

4.1 Macroinvertebrate Collection and Analyses

A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003b). Three standard habitats--depositional substrate in non-flowing water, rootmat at the stream edge, and large woody debris--were sampled at all locations.

A standardized sample analysis procedure was followed as described in the SMSBPP. The following four metrics were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). These metrics are scored and combined to form the Stream Condition Index (**SCI**). Stream Condition Indices between 20-16 qualify as biologically supporting, between 14-10 are partially supporting, and 8-4 are considered non-supporting of aquatic life. The multi-habitat macroinvertebrate data are presented in Appendix D as laboratory bench sheets.

Additionally, macroinvertebrate data were analyzed in three specific ways. First, comparisons were made between longitudinal reaches. This comparison addresses influences that may result from influxes from such sources as stormwater, wastewater, and tributaries. Longitudinal patterns for Miami Creek are illustrated using XY line graphs with stream location (station number) on the X-axis and biological characteristics on the Y-axis. Data are also summarized and presented in tabular format comparing means of the four standard metrics and other parameters at each of the stations on Miami Creek. Finally, the data from Miami Creek were compared to biological criteria from reference streams within the same watershed size classification and within the same (and an adjacent) EDU. Biocriteria data collected from fall 2003 as well as previous survey years constituted the basis of the comparison. Glide/pool reference streams from adjacent EDUs (Little Drywood Creek in the Plains/Osage EDU and East Fork Crooked River in the Plains/Missouri River Tributaries between the Blue and Lamine Rivers EDU) were combined for the purposes of calculating biological criteria and taxa comparisons.

4.2 Physicochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations. Field measurements included temperature (ºC), dissolved oxygen (mg/L), conductivity (µS/cm), and pH. Additionally, water samples were collected and analyzed by ESP's Chemical Analysis Section for turbidity (NTU), chloride, total phosphorus, ammonia-N, nitrate+nitrite-N, and total Kjeldahl nitrogen (**TKN**) (with the exception of turbidity, all parameters reported in mg/L). Procedures outlined in Field Sheet and Chain of Custody Record (MDNR 2001) and Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003d)

were followed when collecting water quality samples. Stream velocity was measured at each station during the survey period using a Marsh-McBirney Flo-Mate™ Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113, Flow Measurement in Open Channels (MDNR 2003a).

Stream habitat characteristics for each sampling station were measured during the spring 2004 survey period using a standardized assessment procedure as described for glide/pool habitat in the Stream Habitat Assessment Project Procedure (MDNR 2003c).

Physicochemical data were summarized and presented in tabular form for comparison among stations on Miami Creek.

4.3 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the SMSBPP and in accordance with the Fiscal Year 2004 Quality Assurance Project Plan for "Biological Assessment."

5.0 Data Results

5.1 Physicochemical Data

Physical characteristics of Miami Creek sample stations are presented in Table 2. Average stream widths at Miami Creek ranged from 29 to 41 feet, with widths varying little among stations regardless of their position in the watershed. Stream flow during the fall sample season was very low, such that variability from stream hydraulics and transect placement could account for the small differences in width observed among sites. Stream flow during the spring 2004 sample season was greatly elevated compared to its historic mean (based on two years of gaging station flow data). On the day we sampled macroinvertebrates in March, the mean stream flow at U.S. Geological Survey Gaging Station 06916675, which is approximately 1 mile downstream from Station 3, was 13.9 cfs. By comparison, our measurements indicated flow to be 52.7 cfs on this day. During the spring, flow generally increased while progressing downstream. At several sites, high flow combined with steep stream banks made thorough macroinvertebrate sampling extremely difficult.

Table 2
Physical Characteristics of the Miami Creek Sample Stations

Station	Avg. Width (ft.)	Fall 2003 Flow (cfs)	Spring 2004 Flow (cfs)
1	41	0.81	81.6
2	41	0.88	95.8
3	29	0.06	52.7
4	35	1.77	41.9
5	38	0.00	29.8

In situ water quality measurements are summarized in Tables 3 and Table 4. Temperature readings varied seasonally, with mean temperatures higher in the fall (19.7ºC) than in the spring (7.2ºC). Temperature among Miami Creek sites was stable during both sample seasons, varying no more than 2.5ºC in the fall and 1.0ºC in the spring. The lowest fall temperature reading was recorded at Station 3; this reading also was recorded earlier in the day (0830h) than the remaining Miami Creek sites, which were all collected after 1040h.

Table 3
Fall 2003 *In situ* Miami Creek Water Quality Measurements

	Parameter				
Station	Temperature (ºC)	Dissolved O_2 (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)
1	20.5	4.8	293	7.5	9.68
2	20.0	4.6	340	7.6	9.29
3	18.0	2.93	335	7.5	6.98
4	20.0	6.12	434	7.3	5.28
5	20.0	3.8	230	7.6	14.5

Table 4
Spring 2004 *In situ* Miami Creek Water Quality Measurements

	Parameter				
Station	Temperature (ºC)	Dissolved O_2 (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)
1	7.0	10.6	463	8.1	26.7
2	7.0	11.3	492	7.7	29.0
3	8.0	10.9	496	7.8	19.2
4	7.0	12.0	466	8.1	16.0
5	7.0	12.6	435	8.1	14.3

Turbidity levels were roughly three times higher in spring samples than fall samples for each site except Station 5. Turbidity at Station 5 was nearly identical among seasons.

Compared to the fall 2003 season, pH readings were slightly higher at the Miami Creek stations during the spring 2004 season. These differences were small, however, with the two extremes varying by 0.8. When comparing pH within seasons, the variability was even less, with readings among stations having a difference of no more than 0.3.

Conductivity readings also were higher during the spring sample season at all stations. This difference between seasons was less pronounced at Station 4, which had higher readings than the remaining stations during the fall season. More variability was observed in conductivity among fall samples, with readings ranging from 230 to 434 µS/cm, compared to spring samples which ranged from 435 to 496 µS/cm. The highest

fall season conductivity, which occurred at Station 4, is likely linked to the relatively high chloride concentration (53.1 mg/L) also observed at this site.

Dissolved oxygen concentrations were considerably lower during the fall season. At all sites except Station 4, dissolved oxygen levels were below the 5 mg/L minimum concentration listed in the Missouri Water Quality Standards for protection of aquatic life (warmwater and coolwater fisheries). During the spring season, dissolved oxygen concentrations were much higher, with levels being at least twice the minimum standard.

Nutrient concentrations as well as chloride concentrations are presented in Table 5 (fall 2003) and Table 6 (spring 2004). Nutrient concentrations were variable among seasons, sample sites, and the parameters tested, with few distinct patterns. Ammonia as nitrogen (NH_3-N) was present in detectable levels at the majority of sites during both sample seasons. In fall 2003 ammonia concentrations were highest in the middle of the survey reach, but were undetectable at both the up and downstream extremes. In spring 2004, ammonia levels were higher in downstream samples but at or near non-detectable levels at the two most upstream stations. Nitrite+nitrate as nitrogen (NO_2+NO_3-N) was present in detectable levels in the lower three stations in fall 2003 and at all stations in spring 2004. Concentrations of NO_2+NO_3-N were slightly higher at Stations 1 and 2 in fall samples whereas each of the lower four stations were high relative to the uppermost site in spring. Total Kjeldahl nitrogen (TKN), total phosphorus, and chloride all were present in detectable levels at each station during both sample seasons. Concentrations of TKN were slightly higher in the upstream three stations in fall samples, but were highest in the two downstream stations in spring. Total phosphorus tended to be higher in the fall with the exception that Station 4 fall samples had the lowest levels among all sites for both seasons. During both sample seasons, total phosphorus was higher at each of the downstream sites. Chloride levels were slightly higher in spring samples, except that levels were substantially higher at Station 4 in the fall. One trend among nutrient parameters occurred in spring samples at Station 2, which was the first Miami Creek sample station downstream of Mound Branch--the receiving system for the Butler Wastewater Treatment Facility. With the exception of TKN, each nutrient parameter tested in spring samples was highest at Station 2; no such trend, however, was evident in the fall samples.

Table 5
Fall 2003 Miami Creek Nutrient Concentrations

	Parameter (mg/L)				
Station	NH_3-N	NO_2+NO_3-N	TKN	Total Phosphorus	Chloride
1	0.03*	0.10	0.95	0.30	11.2
2	0.08	0.18	0.96	0.29	17.0
3	0.34	0.02	1.26	0.25	12.5
4	0.45	0.01*	1.08	0.04	53.1
5	0.03*	0.01*	1.09	0.22	3.46

*Below detectable levels

Table 6
Spring 2004 Miami Creek Nutrient Concentrations

	Parameter (mg/L)				
Station	NH_3-N	NO_2+NO_3-N	TKN	Total Phosphorus	Chloride
1	0.22	1.76	1.18	0.14	21.6
2	0.37	2.76	1.00	0.18	29.2
3	0.17	1.99	0.76	0.12	20.5
4	0.05	1.21	0.59	0.09	16.3
5	0.03*	0.83	0.35	0.06	12.4

*Below detectable levels

5.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 7. According to the project procedure, for a study site to fully support a biological community, the total score from the physical habitat assessment should be 75% to 100% similar to the total score of a reference site. The mean habitat score for Little Drywood Creek and East Fork Crooked River, the biocriteria reference streams used for comparison, was 115. The mean habitat score among Miami Creek sites was 121. Because all Miami Creek stations had habitat scores that exceeded or were within the required range of similarity, it was inferred that the sites should support comparable biological communities.

Table 7
Reference Streams and Miami Creek Habitat Assessment Scores

Reference Streams	Habitat Score	Miami Creek Sample Stations	Habitat Score	% of Mean Reference
Little Drywood #1	106	1	92	80
Little Drywood #2	122	2	133	116
EF Crooked River	117	3	113	98
		4	126	110
		5	139	121
Mean Reference Stream Score	**115**			

5.3 Biological Assessment

5.3.1 Miami Creek Longitudinal Comparison

Metrics calculated for Miami Creek were compared to biological criteria based on reference sites from the Plains/Osage EDU and the Plains/Missouri River Tributaries between the Blue and Lamine River EDU. These criteria for fall and spring sample

seasons--presented in Tables 8 and 9--were used to assess the overall health of the aquatic community relative to reference communities within these EDUs.

Table 8
Biological Criteria for Warm Water Reference Streams in the Plains/Osage EDU, Fall Season

	Score = 5	Score = 3	Score = 1
TR	>57	57-28	<28
EPTT	>6	6-3	<3
BI	<7.63	7.63-8.82	>8.82
SDI	>2.86	2.86-1.43	<1.43

Table 9
Biological Criteria for Warm Water Reference Streams in the Plains/Osage EDU, Spring Season

	Score = 5	Score = 3	Score = 1
TR	>50	50-25	<25
EPTT	>8	8-4	<4
BI	<7.16	7.16-8.58	>8.58
SDI	>2.29	2.29-1.14	<1.14

No trends among the stations' metric values were observed relative to their position in the watershed in either sample season (Table 10 and Table 11). During the fall season, Taxa Richness ranged from 73 at Station 1 to 55 at Station 5. Despite the two extremes in Taxa Richness occurring at each end of the survey reach, no longitudinal trend was

Table 10
Miami Creek Metric Values and Scores, Fall 2003 Season, Using Plains/Osage Biological Criteria Reference Database

Site	TR	EPTT	BI	SDI	SCI	Support
#1 Value	73	6	7.95	3.22		
#1 Score	5	3	3	5	16	**Full**
#2 Value	62	7	7.94	2.73		
#2 Score	5	5	3	3	16	**Full**
#3 Value	57	4	7.88	3.14		
#3 Score	3	3	3	5	14	**Partial**
#4 Value	72	6	7.98	3.52		
#4 Score	5	3	3	5	16	**Full**
#5 Value	55	2	8.08	2.72		
#5 Score	3	1	3	3	10	**Partial**

Table 11
Miami Creek Metric Values and Scores, Spring 2004 Season, Using Plains/Osage Biological Criteria Reference Database

Site	TR	EPTT	BI	SDI	SCI	Support
#1 Value	58	5	8.17	3.10		
#1 Score	5	3	3	5	16	**Full**
#2 Value	59	6	8.29	2.78		
#2 Score	5	3	3	5	16	**Full**
#3 Value	53	3	7.05	2.68		
#3 Score	5	1	5	5	16	**Full**
#4 Value	58	5	8.03	2.94		
#4 Score	5	3	3	5	16	**Full**
#5 Value	54	5	7.81	2.78		
#5 Score	5	3	3	5	16	**Full**

observed, as evidenced by the second highest Taxa Richness value occurring at Station 4, the nearest downstream site from Station 5. In addition to having the lowest Taxa Richness, Station 5, the uppermost sample reach, exhibited the fewest EPT Taxa and the lowest Shannon Diversity Index as well as the highest Biotic Index values. Little variability among these three metrics was observed in the lower four stations, however. In the spring season there was very little variability in Taxa Richness (Figure 1) or EPT Taxa (Figure 2) among stations. Taxa Richness ranged from 59 at Station 2 to 53 at Station 3, whereas EPT Taxa values ranged from 6 at Station 2 to 3 at Station 3. Biotic Index scores were slightly higher at the lower two stations, but were sufficiently similar to have scores equal to the upstream two sites. Only Station 3 had a sufficiently low Biotic Index value to achieve the top score for that metric. The highest Shannon Diversity Index value occurred at Station 1; however, each station's SDI was sufficient to merit the highest possible score.

Although two of the five sites failed to achieve the rank of fully supporting in fall 2003, their position within the watershed did not appear to be a factor. Station 3 and Station 5 both had partially supporting rankings, but Station 4, which was situated between the two, was fully supporting. Both stations that were ranked as partially supporting during the fall season had lower Taxa Richness than the remaining stations, whereas scores of the remaining metrics were variable. The lowest sustainability score among fall samples occurred at Station 5 with each of the four metrics achieving lower scores compared to the remaining stations. During the spring 2004 season, all five sites achieved a fully supporting ranking. All sites except Station 3 exhibited the same scoring pattern among the four metrics. Station 3 had a lower EPT Taxa score and a higher Biotic Index score than each of the remaining sites. The higher Biotic Index score served to offset the lower EPT Taxa score, with the result being a sustainability score equal to the remaining sites.

Figure 1: Miami Creek Taxa Richness

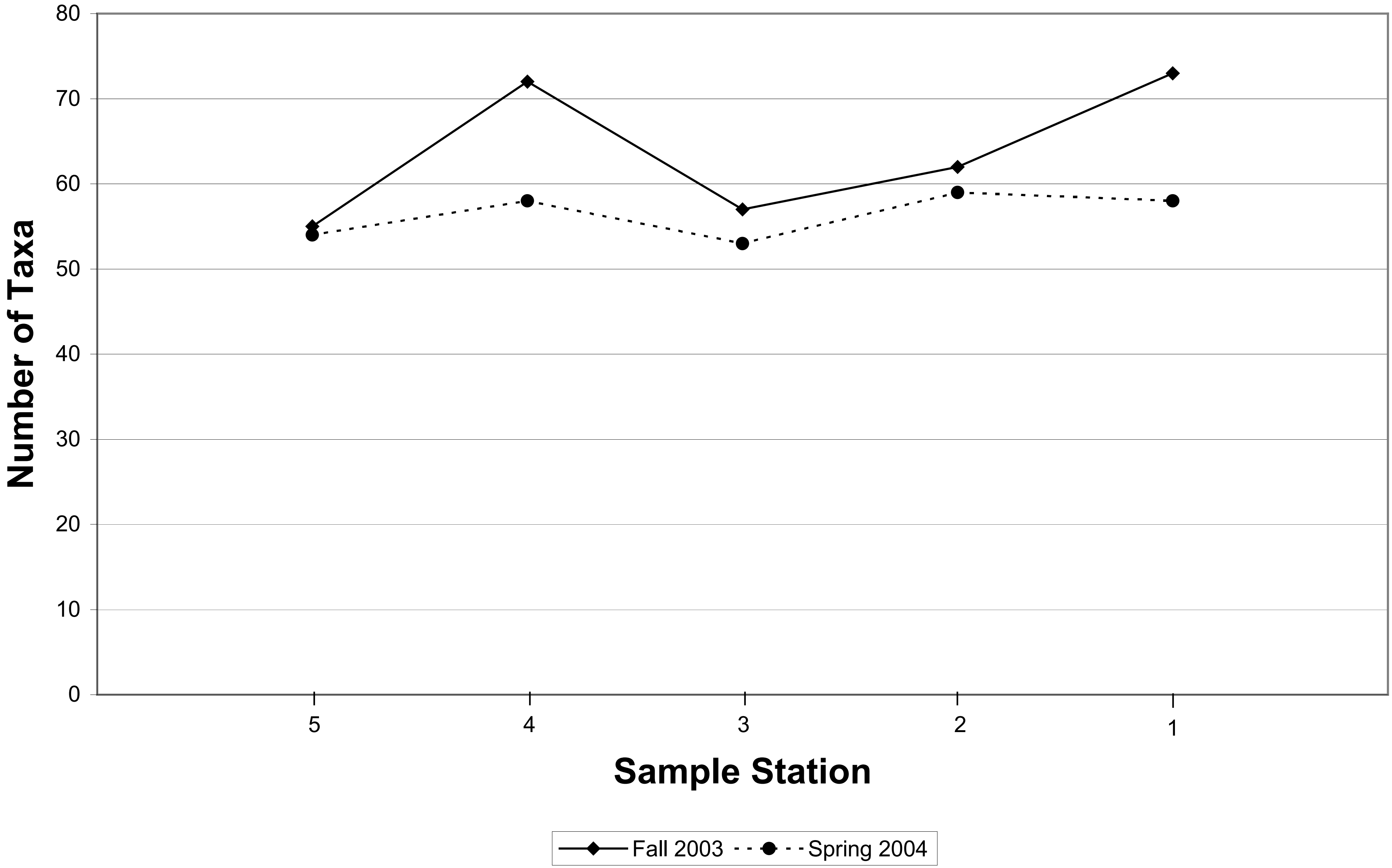
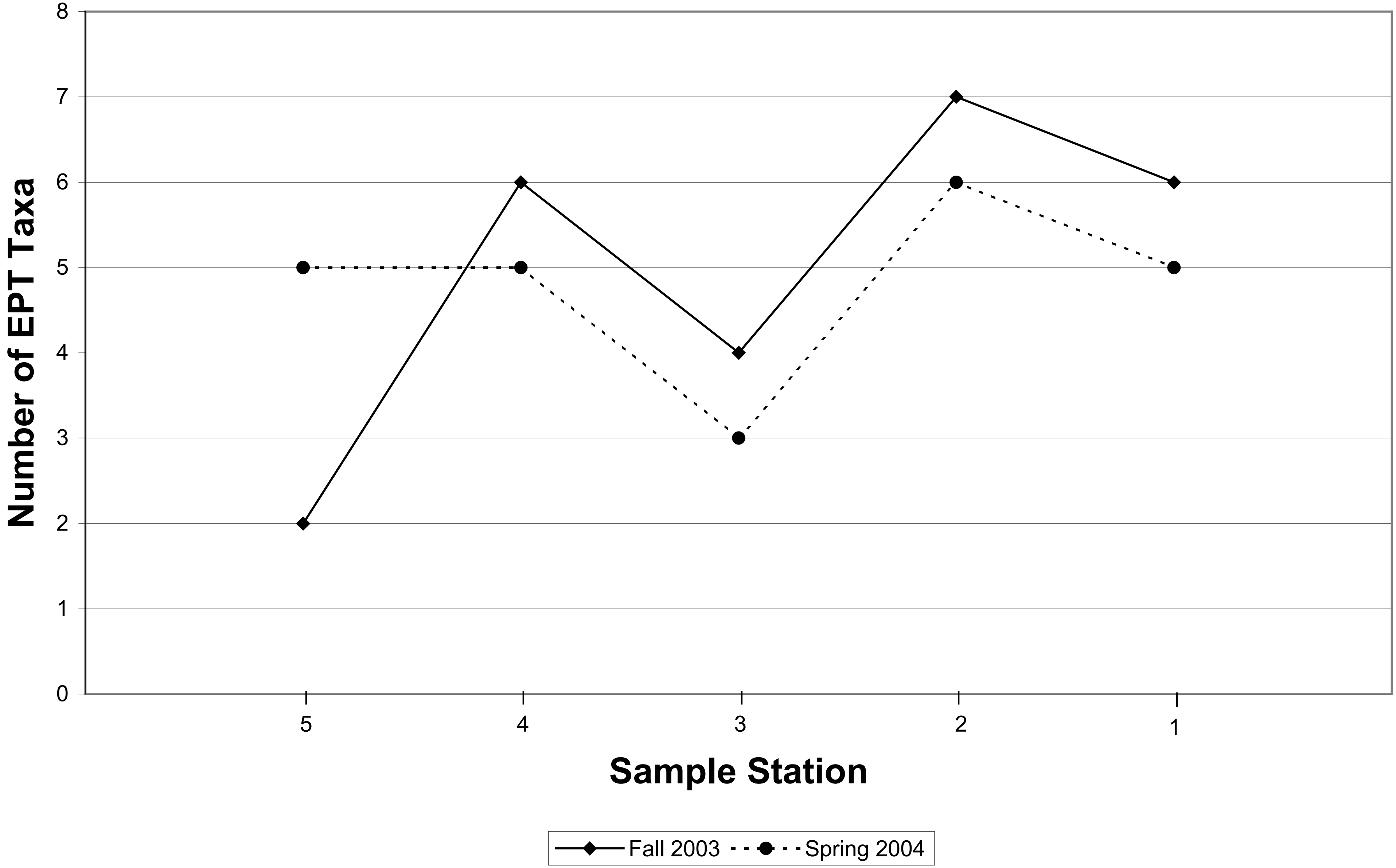


Figure 2: Miami Creek EPT Taxa



5.3.2 Macroinvertebrate Percent and Community Composition

Macroinvertebrate Taxa Richness, EPT Taxa, and percent EPT are presented in Table 12 and Table 13. These tables also provide percent composition data for the five dominant macroinvertebrate families at each Miami Creek station. The percent relative abundance data were averaged from the sum of three macroinvertebrate habitats--nonflow, large woody debris, and rootmat--sampled at each station.

Fall 2003 macroinvertebrate samples from Miami Creek averaged 64 total taxa (range 55-73) and 5 EPT Taxa (range 2-7). Midge larvae (Chironomidae) were the dominant taxa and aquatic worms (Tubificidae) were second in abundance at Stations 1, 3, and 4. Tubificid worms were the dominant taxa at Station 5 and amphipods (Amphipoda: Hyalellidae) were dominant at Station 2. Chironomids and tubificids were among the five dominant taxa at all Miami Creek sites and amphipods were among the dominant taxa at all but Station 5. The highest percentage of mayflies occurred at Station 2, where 7.3 percent of individuals were mayflies. A single species, *Caenis punctata* (a member of the squaregill mayfly family), comprised over 90 percent of all mayflies in the Station 2 sample. This species also was relatively abundant at Station 4, where it comprised 73 percent of mayflies in the sample. Caddisflies (Trichoptera) were relatively rare in Miami Creek samples. Station 1 had the greatest caddisfly abundance, accounting for 5 percent of all individuals. A single genus, *Cheumatopsyche*, was the dominant caddisfly in the Station 1 sample, comprising 78 percent of caddisfly taxa. Caddisfly taxa made up ≤1 percent of individuals in samples collected from the upstream four stations and were absent from Station 5 samples. No stoneflies (Plecoptera) were present among fall samples.

Spring 2004 macroinvertebrate samples averaged 56 total taxa (range 53-58) and 5 EPT Taxa (range 3-6). Chironomids were the dominant group at all but Station 3, where black fly larvae (Simuliidae) were slightly more abundant. Aquatic worms (Oligochaeta: Tubificidae and Enchytraeidae) were among the five dominant taxa at all stations and amphipods were among the dominant taxa at all but Station 1. Station 2 had the highest percentage of mayflies, followed by Station 4 and Station 1. Mayfly taxa comprised less than 1 percent of individuals in samples collected from Station 3 and Station 5. As was observed in the fall samples, a single species dominated the mayfly count. Another squaregill mayfly species, *Caenis latipennis*, comprised 90 percent of mayflies at Station 4, 88 percent at Station 2, 60 percent at Station 5, and 50 percent at Stations 1 and 3. It should be noted that *C. latipennis* was one of only two mayfly taxa at Stations 3 and 5 and that ≤5 mayfly individuals were present in samples collected from these stations. Although caddisflies were present in all Miami Creek samples collected during the spring season, they were collected in lower numbers compared to fall samples. Only one genus, *Ironoquia*, was represented by more than a single individual in spring samples. Station 2, which had the highest number of *Ironoquia*, also had the highest percentage (0.6) of caddisflies among stations during the spring season. A single stonefly taxon, *Allocapnia* (in the family of slender winter stoneflies), was collected at Station 5 in spring 2004.

Table 12
Fall 2003 Miami Creek Macroinvertebrate Composition

Variable-Station	1	2	3	4	5
Taxa Richness	73	62	57	72	55
Number EPT Taxa	6	7	4	6	2
% Ephemeroptera	1.2	7.3	2.8	5.2	2.1
% Plecoptera	0.0	0.0	0.0	0.0	0.0
% Trichoptera	5.0	1.0	0.1	0.8	0.0
% Dominant Families					
Chironomidae	31.4	15.6	32.4	24.1	15.0
Tubificidae	21.1	18.6	12.6	20.0	35.6
Crangonyctidae	8.2	-	-	-	-
Hyalellidae	6.5	33.7	11.0	9.9	-
Sphaeriidae	5.6	-	-	-	-
Caenidae	-	6.6	-	-	-
Coenagrionidae	-	5.1	-	10.8	-
Ceratopogonidae	-	-	11.9	6.9	-
Scirtidae	-	-	6.1	-	8.4
Corixidae	-	-	-	-	14.8
Physidae	-	-	-	-	4.7

Table 13
Spring 2004 Miami Creek Macroinvertebrate Composition

Variable-Station	1	2	3	4	5
Taxa Richness	58	59	53	58	54
Number EPT Taxa	5	6	3	5	5
% Ephemeroptera	2.4	6.7	0.4	4.3	0.8
% Plecoptera	0.0	0.0	0.0	0.0	0.1
% Trichoptera	0.1	0.6	0.1	0.4	0.3
% Dominant Families					
Chironomidae	40.6	26.0	27.4	56.4	43.4
Tubificidae	25.3	11.4	20.7	3.2	26.3
Enchytraeidae	7.1	7.7	-	5.2	3.3
Ceratopogonidae	5.0	-	-	-	-
Sphaeriidae	4.6	-	-	-	-
Hyalellidae	-	24.9	2.7	8.7	4.6
Crangonyctidae	-	11.4	-	-	-
Simuliidae	-	-	32.5	-	9.7
Physidae	-	-	3.2	-	-
Caenidae	-	-	-	3.9	-

5.3.3 Comparisons of Miami Creek versus Plains/Osage EDU Biological Criteria Reference Sites

Macroinvertebrate data for two biocriteria reference streams sampled in fall between 1995 and 2003 are presented in Table 14 and spring samples collected between 1995 and 2000 are presented in Table 15. Taxa Richness averaged 61 (range 53 to 69) in fall and 62 (range 48 to 74) in spring samples. Total EPT Taxa averaged 7 (range 5 to 10) in fall and nearly 12 (range 7-16) in spring samples. Little Drywood fall 2003 metrics and macroinvertebrate community composition were most similar to Miami Creek fall data. As was the case at Miami Creek, chironomids and tubificid worms were among the most dominant taxa at all Little Drywood sites. Compared to Miami Creek, mayfly abundance tended to be similar to or slightly higher in fall 2003 samples collected from Little Drywood Station 1 and Station 3. At Little Drywood Station 4, however, pronggill mayflies (Leptophlebiidae) were very abundant compared to the other Little Drywood and Miami Creek stations, second only to chironomids. Mayflies comprised approximately 25 percent of samples in 7 of the 11 stations and years for which samples were collected from biocriteria reference streams. The four instances in which mayflies were relatively rare occurred at Little Drywood Creek stations in 1998 and 2003. Tubificid worms were among the five dominant taxa in each Little Drywood sample, but in only one of the three East Fork Crooked River samples. The highest tubificid abundance occurred in Little Drywood samples collected in fall 2003. As was observed at Miami Creek, abundance of caddisflies in reference streams was variable among years and sites. Caddisflies comprised from 0 to 7.5 percent of individuals in samples at the reference sites. No stoneflies were present in any fall samples collected from either reference stream.

No spring 2004 samples were collected from the two reference streams. Considerable variability exists among samples collected from the reference streams between 1995 and 2000. Although macroinvertebrate metrics tend to be higher among the reference streams, there are also instances in which certain Miami Creek metrics are higher. Overall, mayfly taxa comprised a higher percentage of samples in the reference streams. Two notable exceptions exist, however, from East Fork Fishing River and Little Drywood Creek in 2000. Caddisflies tended to make up a higher percentage of samples at the reference streams, but the difference was slight. Of note was the difference in the presence of stoneflies. Whereas only a single stonefly individual was collected among five Miami Creek stations, stoneflies were collected from each of the reference stations in every year sampled. Although stoneflies comprised a noticeable percentage of individuals in samples, they were never present in sufficient numbers to be among the five dominant taxa. Chironomids were the dominant group among each reference station sampled, and in five of seven samples comprised approximately half or more of all individuals in samples. Tubificid worms were consistently among the top five dominant taxa among reference streams, with the exception of a 1995 Little Drywood Creek sample.

Table 14
Plains/Osage EDU and Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biological Criteria Reference Stream Macroinvertebrate Composition, Fall Season

	East Fork Crooked River			Little Drywood Creek							
Sample Year	1999	1999	2000	1995	1995	1998	1998	2000	2003	2003	2003
Station-Variable	1a	1b	1	1	2	2	5	5	1	3	4
Taxa Richness	62	62	59	55	53	64	63	69	67	62	53
Number EPT	8	10	6	8	7	6	5	10	7	7	5
% Ephemeroptera	28.2	26.5	23.3	27.3	21.5	4.5	12.2	39.2	6.2	8.0	24.7
% Plecoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Trichoptera	1.1	7.5	2.0	2.2	1.1	0.7	0.0	2.7	0.0	0.7	0.2
% Dominant Families											
Chironomidae	34.3	30.2	25.8	37.3	45.2	44.4	56.3	49.8	27.0	27.6	27.5
Heptageniidae	20.1	16.3	14.2	15.4	9.1	--	2.5	--	--	--	--
Elmidae	14.3	20.2	6.1	--	--	--	--	--	--	--	--
Tubificidae	9.1	--	--	9.8	6.3	8.9	10.2	3.5	16.7	16.9	15.1
Coenagrionidae	7.0	--	--	--	6.9	5.7	--	10.6	--	--	--
Caenidae	--	7.9	7.1	--	--	--	8.3	14.2	--	--	--
Leptoceridae	--	6.6	--	--	--	--	--	--	--	--	--
Corixidae	--	--	16.0	--	--	--	--	--	8.6	--	--
Hyalellidae	--	--	--	7.9	--	--	--	--	13.6	8.6	4.0
Leptophlebiidae	--	--	--	7.3	10.2	--	--	--	--	--	22.3
Physidae	--	--	--	--	--	6.9	--	--	--	--	--
Sphaeriidae	--	--	--	--	--	5.5	--	--	--	--	--
Chaoboridae	--	--	--	--	--	--	8.3	--	--	--	--
Scirtidae	--	--	--	--	--	--	5.1	--	--	--	--
Ephemeridae	--	--	--	--	--	--	--	4.3	--	--	--
Asellidae	--	--	--	--	--	--	--	--	12.1	13.1	11.0
Acarina	--	--	--	--	--	--	--	--	--	6.2	--

Table 15
Plains/Osage EDU and Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU
Biological Criteria Reference Stream Macroinvertebrate Composition, Spring Season

	East Fork Crooked River		Little Drywood Creek				
Sample Year	1999	2000	1995	1995	1998	1998	2000
Station-Variable	1	1	1	2	2	5	5
Taxa Richness	65	48	50	56	69	73	74
Number EPT	13	7	8	10	13	16	14
% Ephemeroptera	16.7	0.5	20.4	14.2	9.6	12.1	4.5
% Plecoptera	0.4	0.1	3.9	4.3	3.0	3.1	0.5
% Trichoptera	3.4	0.4	0.3	4.3	0.8	0.5	0.9
% Dominant Families							
Chironomidae	70.9	66.4	27.8	48.6	31.7	46.9	56.1
Baetidae	9.2	--	--	--	--	--	--
Heptageniidae	5.9	--	7.9	8.4	--	2.6	--
Tubificidae	3.3	15.6	--	5.2	14.5	17.2	12.0
Hydropsychidae	3.1	--	--	--	--	--	--
Ceratopogonidae	--	7.6	--	--	--	--	3.4
Simuliidae	--	3.3	18.0	--	23.8	5.2	4.1
unidentified Diptera	--	1.7	--	--	--	--	--
Hyalellidae	--	--	13.1	5.5	--	--	--
Caenidae	--	--	9.7	--	4.3	6.6	--
Asellidae	--	--	--	3.7	8.2	6.6	--
Acarina	--	--	--	--	--	--	3.3

6.0 Discussion

The Marais des Cygnes River system, of which Miami Creek is part, was the subject of an extensive channelization project that began in 1906 and was completed in 1911 (Atkenson 1918). Channelization of the lower 44 miles of the Marais des Cygnes River resulted in the loss of approximately 18 miles of channel length (35 percent of the river's total length) and the creation of the 23 mile long Bates County Drainage Ditch. Flow in the Marais des Cygnes mainstem above Miami Creek has been reduced to occurring only during floodwater events. Channelization has greatly increased the gradient of the system. The original gradient of the Marais des Cygnes River channel was 0.81 feet per mile compared to the current 2.06 feet per mile gradient of the Bates County Drainage Ditch (Dent et al. 1998). This increased gradient has led to headcutting and resultant bank instability. In some sections, headcutting has created channels over 60 feet deep and 200 feet wide (MDC 1990). In areas where headcutting has degraded the channel to bedrock, the channel will likely undergo lateral migration to restabilize--a process that some observers predict will take hundreds of years (Dent et al. 1998). In the course of channel restabilization, river beds will continue to cut deeper and river banks will slough

as the channel migrates, resulting in increasing sedimentation downstream, not only in the river itself but also in the Osage River and Truman Reservoir.

In addition to channelizing the mainstem of the Marais des Cygnes River, several tributary streams, including Miami Creek, were subject to a process known as "lateral straightening" (Dent et al. 1998). Even streams that were not directly subjected to channelization efforts will likely be affected. For example, headcutting will affect not only the Bates County Drainage Ditch, but also each of its tributaries, eventually working through the entire system. With headcutting resulting in a deeper channel within the Bates County Drainage Ditch, the Marais des Cygnes upstream of Miami Creek has been largely dewatered and is filling with sediment. Miami Creek, rather than succumbing to lateral straightening efforts, continues to flow in its original channel to the Marais des Cygnes River, an aggrading system. Because of these factors, instability in Miami Creek directly attributable to channelization (e.g. headcutting, bank sloughing, and resultant sedimentation) may not exist. Without a comprehensive survey, however, identification of headcuts or other factors of instability related to channelization will be difficult. In fact, because the first topographic maps of the area were not printed until 1934 (>30 years after the system's channelization project was complete), it may be impossible to document the full extent of changes that have occurred throughout the watershed (Dent et al. 1998).

Sedimentation may be an ongoing phenomenon in the Miami Creek watershed; however, the extent attributable to poor land use practices is unknown. At the time of this study, loose sediment was not a major component of the benthic substrate, which in most cases was hardpan clay. Loose sediment in the stream channel was typically located at the toe of stream banks that were in the process of experiencing various modes of bank failure.

Whereas non-nutrient water quality parameters varied little among sample stations, there was some variability that was observed among seasons. Conductivity was relatively uniform among stations in spring 2004. During the fall 2003 sample season, however, conductivity readings measured at Station 4 were considerably higher than the other stations. Conductivity at Station 4 was nearly 100 µS/cm higher than the next nearest reading. Chloride concentrations at this site, which were more than three times higher than the second highest level, may contribute to this elevated conductivity reading. The drinking water treatment facility for the City of Butler is approximately 100 yards upstream of Station 4 and may have contributed to the elevated chloride levels. On September 16, 2003, the day prior to our fall sampling at Station 4, a tracer study was conducted at the Butler drinking water facility (Paul Kochan, DNR Kansas City Regional Office, Public Drinking Water Program pers. comm.). During this study, fluoride and chlorinated water were added to the system at a rate of 1110 gallons per minute (approximately 2.5 cfs) for 175 minutes. Dechlorinating agents were added prior to releasing process water to Miami Creek, but it is likely that the elevated chloride concentrations and increased flow observed at this site resulted from the tracer study. Although chloride concentrations are elevated at this site compared to the other Miami

Creek sites, they are much lower than the chronic level of 230 mg/L specified in Missouri's Water Quality Standards for waters whose designated uses include protection of aquatic life. Spring chloride concentrations, although slightly higher at most stations, were more consistent among sites. Increased flow rates in Miami Creek during spring likely provided sufficient dilution and mixing to make chloride concentrations and conductivity readings comparable among the sample stations.

Dissolved oxygen concentrations were below the 5 mg/L minimum threshold at all sample sites except Station 4 during fall 2003. The relatively high dissolved oxygen levels at Station 4 were likely the result of the tracer study conducted at the Butler drinking water facility discussed earlier. Water used in the study had fallen approximately 15 vertical feet from a pipeline outfall into a storage basin (Paul Kochan, pers. comm.). This turbulence would have provided a means of aeration prior to the water's use in the study. Although the lowest dissolved oxygen level was observed in a sample collected in earlier morning (2.93 mg/L at 0830 h), there was no consistent relation between time of day and dissolved oxygen. It is likely that the low flows observed during the fall sample season were preceded by weeks of late summer base flows, which allowed water to become somewhat stagnant and hypoxic. During the spring season, dissolved oxygen concentrations were much higher, with levels being at least twice the minimum standard. Cooler water, which has a higher affinity for dissolved oxygen, coupled with higher stream discharge, with resulting increased turbulence and thus oxygenation, likely contributed to the higher dissolved oxygen concentrations observed in spring.

With the exception of TKN, nutrient parameters were highest in spring 2004 at Station 2, which is located downstream from the mouth of Mound Branch, the receiving system for Butler's Wastewater Treatment Facility (**WWTF**). Although the difference in nutrient parameters among seasons was not overwhelming, it was surprising that many were higher in spring samples, given that there was considerably more flow for dilution compared to the fall. It would be expected that if nutrient levels were higher at a site downstream of a treatment facility, the effect would be more pronounced in the fall or during other low flow conditions when less water is available to dilute effluent entering the system. One explanation may be that in the days preceding our spring sampling, the Miami Creek watershed was subjected to heavy rainfall resulting in floodstage conditions (e.g. according to the U.S. Geological Survey's Gaging Station 06916675, Miami Creek discharge on March 5, 2004 was 2030 cfs). Stormwater from these heavy rains may have exceeded the design capacity of the Butler WWTF, resulting in partially treated wastewater eventually entering Miami Creek.

With the exception of the habitat scores at Station 1, all Miami Creek sample stations had scores equal to or better than those of reference streams. Station 1 had poorer vegetative protection and narrower overall riparian zone width than the remaining stations, resulting in a lower habitat assessment score. Although the banks at Station 1 were not drastically less stable than those of some other sites, the lack of vegetative protection and narrower

riparian zone width may make this sample reach more vulnerable to bank sloughing in the future.

It was somewhat surprising that Station 5, the uppermost station, achieved a partially supporting score with the poorest Taxa Richness and EPT Taxa score as well as the highest Biotic Index value among all stations in fall 2003. Based on first impression, this station appeared ideal, especially when compared to its downstream counterparts. Station 5 was in an area that was heavily wooded, with no agricultural or roadway inputs in sight. The only obvious difference observed at this site was that, despite adequate water and a seemingly abundant quantity of available wetted habitat, there was a lack of measurable surface flow. Station 3 also merited a partially supporting score. Except for Taxa Richness, however, each of the individual metrics scored similarly to the remaining stations that achieved a fully supporting score. It should be noted that the Taxa Richness metric at Station 3 was a single taxon lower than the number necessary to achieve the top score and attainment of full biological support ranking.

Each Miami Creek sample station had identical stream condition index scores in spring 2004, achieving ranks of fully supporting. There was only minor variability among stations in reaching this score. Station 3 exhibited the only difference: the EPT Taxa metric scored a 1 and the Biotic Index metric scored a 5. For all other stations, these metrics' scores were identical. Other than that difference, metric scores were relatively uniform throughout the study reach.

Relatively tolerant taxa dominated the macroinvertebrate community at each Miami Creek station during both sample seasons. Even among dominant groups that have intolerant taxa contributions (e.g. intolerant genera among the family Chironomidae), very few individuals represented the intolerant taxa present.

When comparing Miami Creek to the two biocriteria reference streams, fall 2003 Little Drywood Creek metric scores and macroinvertebrate community composition were most similar to the test stream. This comparison is noteworthy because Little Drywood samples were collected during the same time period as Miami Creek--the result being that the respective macroinvertebrate communities would have been exposed to similar conditions (e.g. flow, temperature) in the months preceding the sample season. In comparing Miami Creek macroinvertebrate data with data collected in prior years from reference sites, there is more dissimilarity among samples. Because a given aquatic community can vary from year to year, the fact that Miami Creek was so similar to a reference stream for which there are closely matched data is encouraging.

A noteworthy difference that Miami Creek spring samples exhibited compared to its references is the relative lack of stoneflies. A single stonefly individual was present among all samples collected from Miami Creek. Although never comprising a sizeable portion of reference samples, stoneflies are nevertheless a consistent contributor to the reference communities. The fact that they were virtually absent in Miami Creek is

curious. It would be interesting to note whether a similar phenomenon existed in either of the reference streams during the spring 2004 season.

7.0 Conclusions

With a few exceptions, Miami Creek macroinvertebrate assemblages were comparable among stations within the study reach during fall 2003. Two study sites, Station 3 and Station 5 failed to score a sufficiently high SCI score to achieve fully supporting status. Lower EPT Taxa and Taxa Richness scores at these sites were the cause of the reduced SCI score. Station 3 would have had an SCI score sufficient to score fully supporting had there been a single additional taxon to supplement the Taxa Richness metric. Lack of flowing water at Station 5 may have been a factor in the lower metric scores observed at that site. In spring 2004 SCI scores among all sites were identical, with each site scoring a fully supporting ranking. Little variability in metric scores was present among sites in the spring.

When comparing Miami Creek to the two biocriteria reference streams, fall 2003 Little Drywood Creek metric scores and macroinvertebrate community composition were most similar to the test stream. More dissimilarity among samples existed when comparing Miami Creek macroinvertebrate data with data collected from reference streams in prior years. A noteworthy difference that Miami Creek spring samples exhibited compared to its references is the relative lack of stoneflies. Although stoneflies do not contribute a sizeable portion of even reference samples, they nevertheless are a consistent contributor to their communities.

Few differences were observed in water quality parameters among sites. Most of these differences occurred when comparing water quality between seasons, but a few additional differences merit attention. During fall 2003, dissolved oxygen concentrations were below the 5 mg/L minimum threshold at all sample sites except Station 4. This trend did not occur, however, during the spring sample season. Chloride and dissolved oxygen concentrations as well as flow and conductivity readings were higher at Station 4 compared to the remaining stations in fall 2003. The city of Butler's drinking water treatment facility, which is just upstream of Station 4, likely contributed to these higher readings by releasing water used in a tracer study. This study, which had required the use of chlorinated water treated with fluoride, was conducted one day prior to our sampling. Despite these elevated chloride readings, they are much lower than the chronic level of 230 mg/L specified in Missouri's Water Quality Standards for waters whose designated uses include protection of aquatic life. Chloride and conductivity readings were comparable among sites during spring 2004. With the exception of TKN, nutrient parameters in spring 2004 were highest at Station 2, which is located downstream from Mound Branch, the receiving system for Butler's Wastewater Treatment Facility.

8.0 Summary

1. Fall 2003 conductivity and chloride levels were highest at Station 4 and may have been caused by discharges associated with a tracer study conducted on the day prior to our sampling.

2. Dissolved oxygen levels were below the 5 mg/L minimum concentration listed in the Missouri Water Quality Standards at all but Station 4 during the fall sample season.

3. Few trends were observed with respect to nutrient parameters among stations or among seasons. Several nutrient parameters sampled in spring 2004 were, however, present in higher concentrations at Station 2, which was the nearest sample site downstream from the Butler WWTF.

4. The lowest habitat assessment score occurred at Station 1. The main causative factors for this low score were sparse vegetative cover along the banks and a narrow riparian corridor. Despite a low score compared to the remaining sites, it was sufficient to assume that the site should, based on habitat availability and quality, support an aquatic community comparable to reference streams.

5. The Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure found that all Miami Creek sample stations were biologically supporting in spring 2004; however, two were partially supporting in fall 2003. Low flows likely caused the partially supporting rank at Station 5. Although Station 3 also was partially supporting in fall 2003, a single macroinvertebrate taxon would have resulted in an SCI score sufficient to merit biologically supporting status.

6. The fall 2003 Miami Creek macroinvertebrate community was most similar to fall 2003 samples collected from Little Drywood Creek, a biocriteria reference stream within the Plains/Osage EDU. More variability existed when comparing data from this study with biocriteria reference data from earlier years.

7. Despite the extensive channelization conducted on Miami Creek's receiving system, the macroinvertebrate community scores were not markedly different from those of reference streams.

8. Although many Miami Creek stream banks were steep and sparsely vegetated, there was not a stark difference compared to those of western Missouri reference streams. Actively degrading channels and raw, exposed banks, features commonly associated with a channelized system, were not readily apparent within the study reach. The lack of these features is not surprising given the fact that efforts to channelize Miami Creek have, as of this writing, failed.

9. Given that the reach of Miami Creek placed on the 303(d) list includes part of Miami Ditch, a channel that has yet to be the primary conduit, the length of the listed reach should be changed from 18 miles to 16.5 miles.

9.0 References Cited

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Appendix A

Proposed Bioassessment Study Plan
Miami Creek
August 13, 2003

Missouri Department of Natural Resources
Bioassessment Study Proposal
Miami Creek, Bates County
August 13, 2003

Objectives

The Miami Creek watershed originates in northwestern Bates County, near the town of Merwin, Missouri and flows southeast to its confluence with the Marais des Cygnes River. The 250 mi^2 watershed is mostly rural, with over 98% of the land use being comprised of cropland, pasture, and woodlands. More than half of the lower 4.5 mi. of Miami Creek, from Highway 71 to the Marais des Cygnes River, is bracketed on one side by a levee. Miami Creek floodwater is partially captured by Miami Ditch, a 7 mi. long channel that is devoid of flow during base flow conditions. The ditch begins approximately 50 m east of the northbound lane of Highway 71 and continues southeast to the Marais des Cygnes River. Miami Creek was placed on the 303(d) list due to potential water quality degradation associated with increasing levels of sediment. We propose, therefore, to conduct a macroinvertebrate, chemical, and physical assessment of Miami Creek. Our objectives are to determine: 1) whether there is aquatic life impairment in the most downstream portions of the creek relative to sections upstream; and 2) whether aquatic life in Miami Creek is impaired relative to that of biocriteria reference streams.

Null Hypotheses

1) The macroinvertebrate assemblages will not differ among reaches of Miami Creek from upstream to downstream.

2) Water chemistry will not differ among reaches of Miami Creek from upstream to downstream.

3) The macroinvertebrate assemblage of Miami Creek will not differ from that found in biocriteria reference streams.

Background

Streams subjected to increased sediment loading can be vulnerable to water quality and habitat degradations. Water quality could be reduced by fertilizers and pesticides that adhere to soil particles, which are then flushed into waterways during storm events. Habitat losses can subsequently result from sediment clogging interstitial spaces in benthic structures that invertebrates use for foraging and protection. In extreme cases, sediment can affect the health of aquatic species by coating and irritating the gills of fish and invertebrates, by covering their nests and smothering eggs, and increasing the turbidity of the water thereby hindering the ability of sight feeders to forage. These potential factors have led to the placement of Miami Creek on the 303(d) List of Impaired Waters. The Missouri Department of Natural Resources (MDNR) will conduct a

macroinvertebrate study and water quality analysis to determine the current status of Miami Creek.

Study Design

General: The study area is included entirely within the approximately 18 mile 303(d) listed reach of Miami Creek. The upstream boundary of the Miami Creek study area is northwest of Butler near the Butler City Lake; the downstream boundary is approximately 1 mi. upstream of Miami Creek's confluence with the Marais des Cygnes River. A total of five stations will be surveyed. The general locations are listed in Table 1 beginning with the most downstream site.

Table 1
Miami Creek Sample Locations

Sample Site	Geographic Location
Miami Creek #1	S. 15; T 39 N; R 31 W
Miami Creek #2	SE ¼ S. 8; T 39 N; R 31 W
Miami Creek #3	NW ¼ S. 6; T 39 N; R 31 W
Miami Creek #4	SE ¼ S. 24; T 40 N; R 32 W
Miami Creek #5	SW ¼ S. 13; T 40 N; R 32 W

Miami Creek is in the Plains/Osage Ecological Drainage Unit. Biological, chemical, and habitat comparisons will be made between the sample locations on Miami Creek and sites on two biological reference streams--Little Drywood Creek and East Fork Crooked River.

Biological Sampling: Each macroinvertebrate station will consist of a length approximately 20 times the average stream width, and will encompass at least two pool/bend sequences . To assess variability and to provide interpretive information among sampling stations, stream discharge measurements, water quality samples, and habitat assessments will be recorded during macroinvertebrate surveys. Sampling will be conducted during fall 2003 (September 15 through September 30) and spring 2004 (March 15 through April 15).

Macroinvertebrates will be sampled according to the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Miami Creek will be considered a "glide/pool" dominated stream, with samples to be collected from depositional (non-flow), rootmat, and woody debris habitats. Macroinvertebrate samples will be a composite of six 1-m^2 kick samples within non-flow habitat, 12 lineal feet of rootmat habitat, and 400 cm^2 from each of 12 pieces of woody debris in varying stages of decomposition.

Water Quality Sampling: Water samples collected from all sampled stations will be analyzed at the ESP laboratory. The samples will be collected per MDNR-FSS-001 (Required/Recommended Containers, Volumes, Preservatives, Holding Times, and

Special Considerations) and MDNR-FSS-002 (Field Sheet and Chain-of-Custody Record). All water samples will be analyzed for ammonia-nitrogen, nitrite+nitrate-nitrogen, total Kjeldahl nitrogen, total phosphorus, chloride, and turbidity. Stream discharge measurements also will be taken at the time of sample collection using a Marsh-McBirney flow meter per MDNR-FSS-113.

Laboratory Methods: All water quality samples will be analyzed at the MDNR ESP laboratory. The samples of macroinvertebrates will be processed and identified per MDNR-FSS-209 (Taxonomic Levels for Macroinvertebrate Identification).

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database in accordance with MDNR-WQMS-214 (Quality Control Procedures for Data Processing). Data analysis is automated within the Access database. A total of four standard metrics will be calculated for each sample reach according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); biotic index (BI); and the Shannon Index (SI). Additional metrics, such as Quantitative Similarity Index for Taxa (QSI-T), or Percent Scrapers (PS) may be used to discern differences in taxa between control and impacted stations.

Macroinvertebrate data will be analyzed in two specific ways. First, a comparison of metrics will be made between sample reaches on Miami Creek upstream and downstream of potential influences (e.g. confluence with Mound Branch, the receiving system for the Butler Wastewater Treatment Facility). Data will be summarized and presented in bar graphs comparing means of the four standard metrics (and other biological parameters) among the five study reaches. Second, Miami Creek data will be compared to that collected at Little Drywood Creek and East Fork Crooked River, two biocriteria reference stream sites.

Ordination of macroinvertebrate data may be performed and regression analysis used to examine potential associations with water chemistry and habitat data. Habitat, fish community, and water quality data also will be used to help interpret macroinvertebrate data.

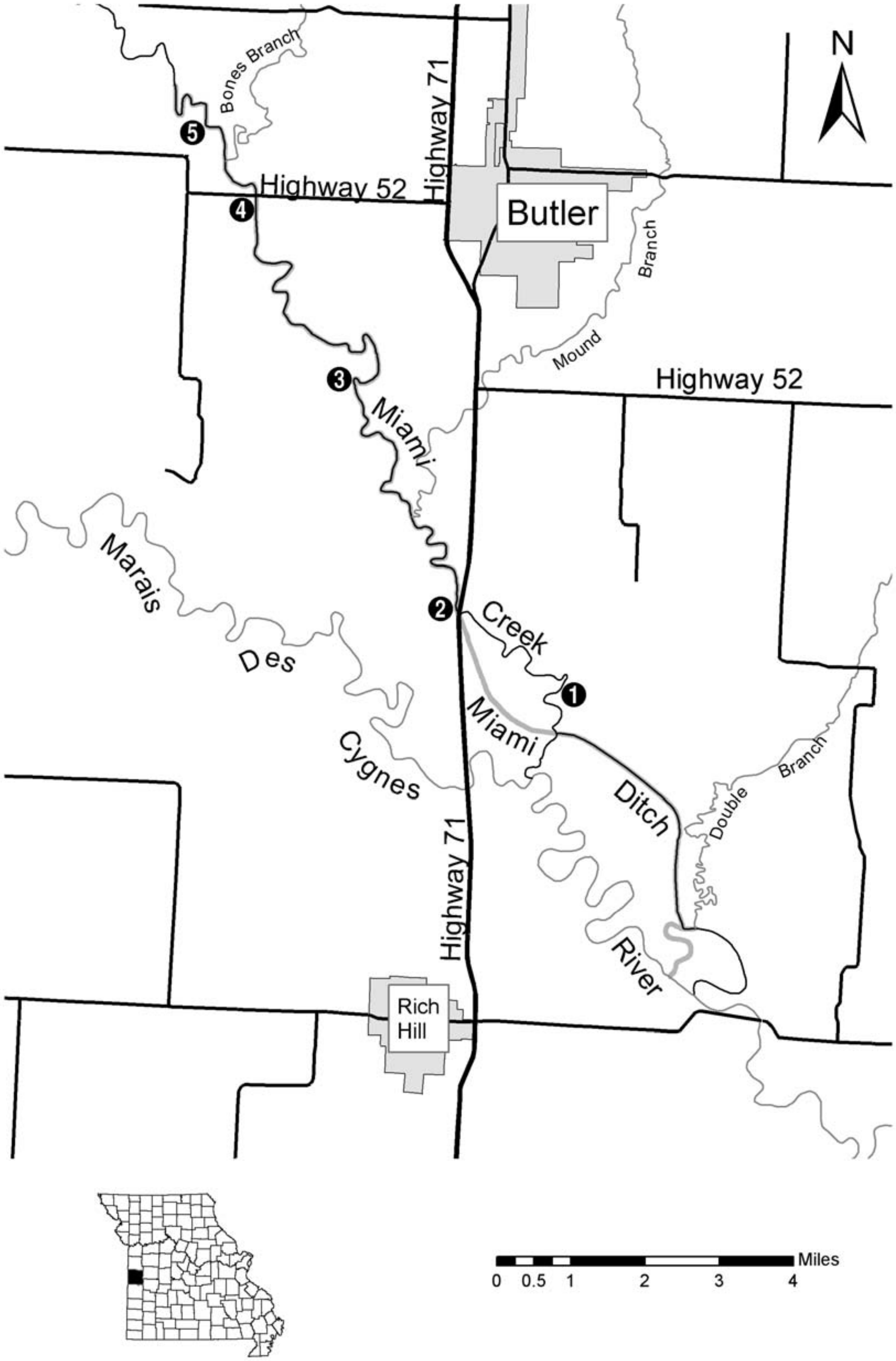
Water quality data will be entered in the Laboratory Information Management System (LIMS) database. Data analysis will be summarized and interpreted using Microsoft Access and Excel software as well as Jandel Scientific software, SigmaStat.

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

Attachments: Map of Miami Creek sampling stations.

Miami Creek
Bates County, Missouri
Bioassessment Sampling Stations



Appendix B

Maps

Miami Creek Sample Stations
Plains/Osage EDU

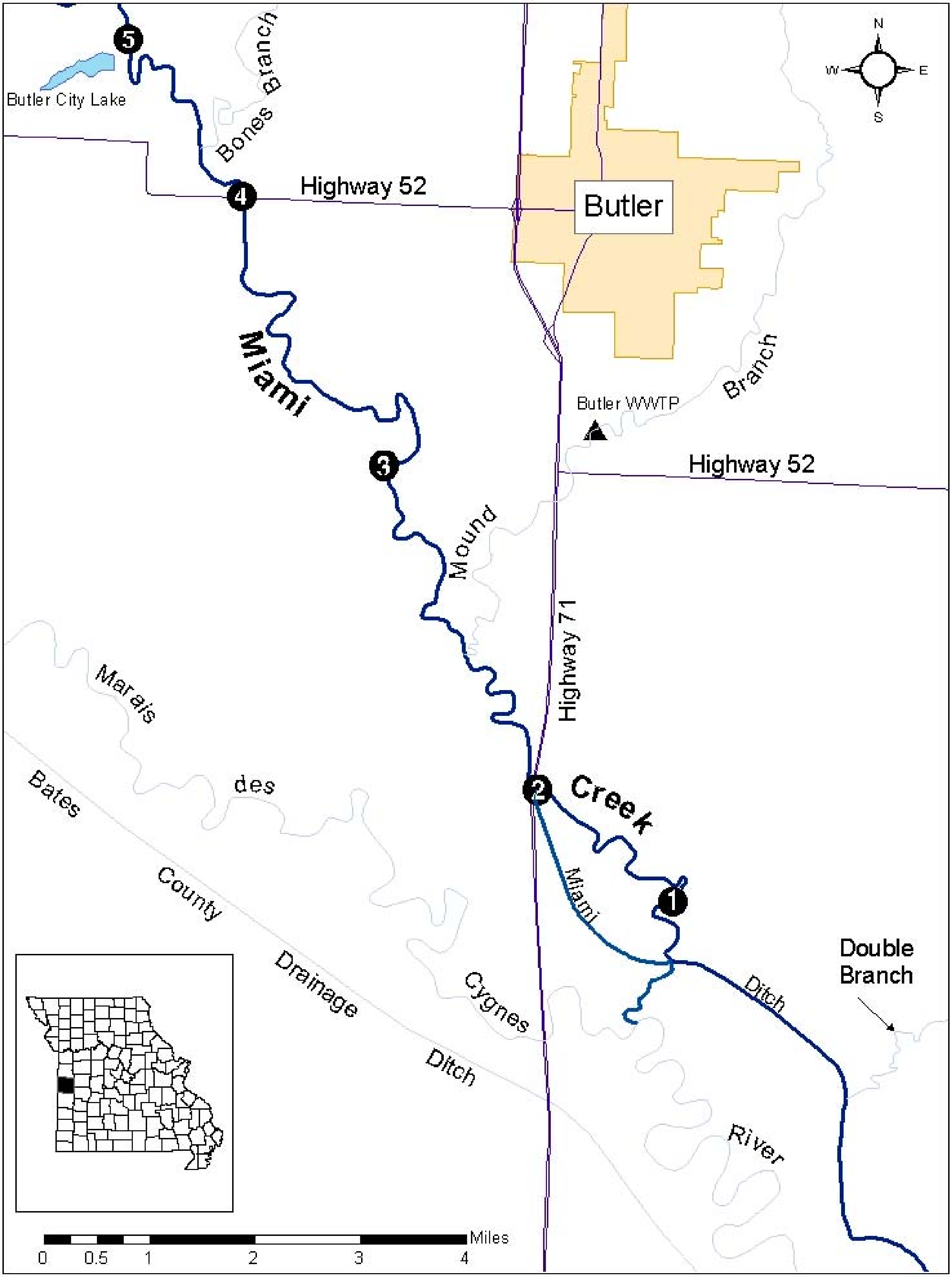
&

Lower Miami Creek with Detail of Miami Ditch
Plains/Osage EDU

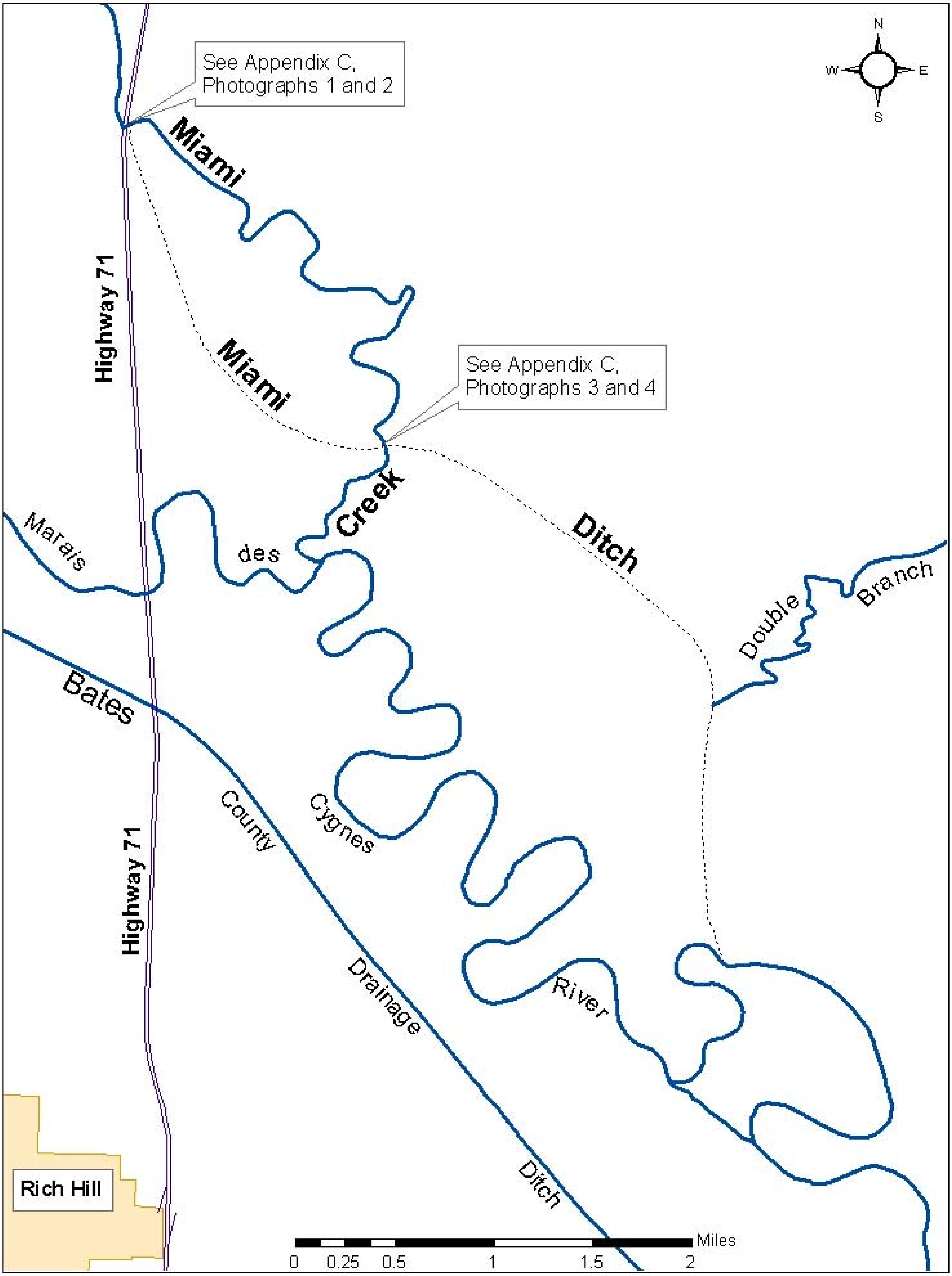
&

Miami Creek Study Area
Plains/Osage EDU

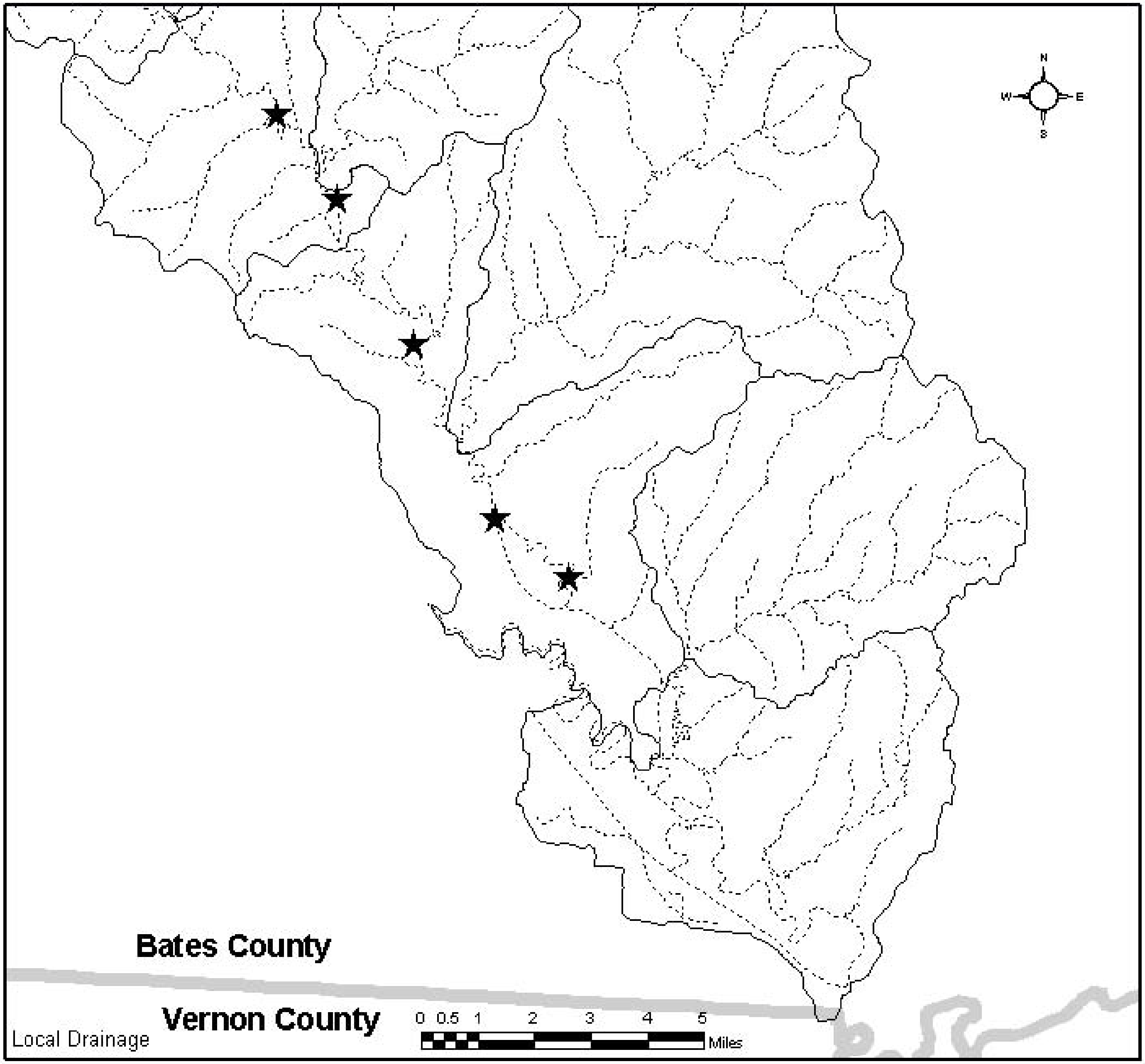
Map 1. Miami Creek Sample Stations



Map 2. Lower Miami Creek



Miami Creek Study Area



★ Sampling Location

County Boundary

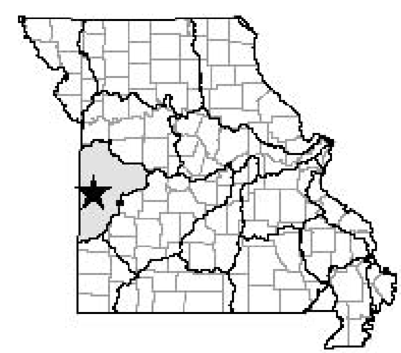
Local Drainage

Stream/River

Local Drainage and Biologic Sampling Site Location

Ecolocial Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as an 11 Digit Hydrologic Unit, is shown in the main map at left. This area is a portion of the local watershed.



Ecological Drainage Unit

Appendix C

Photographs

Photograph 1. Upper end of the Miami Ditch pilot channel. The Highway 71 right of way is visible in the upper right portion of the photo.

Photograph 2. Upper portion of Miami Ditch showing where the ditch bends to flow parallel to Highway 71.

Photograph 3. Downstream intersection of Miami Creek with Miami Ditch.

Photograph 4. Western portion of Miami Ditch flowing into Miami Creek.

Appendix D

Miami Creek Macroinvertebrate Taxa Lists

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0318654], Station #1, Sample Date: 9/16/2003 12:30:00 PM

ORDER: TAXA	**CS**	**NF**	**SG**	**RM**
N/A				
Branchiobdellida				2
"HYDRACARINA"				
Acarina			1	
AMPHIPODA				
Crangonyx				74
Hyalella azteca			6	53
ARHYNCHOBDELLIDA				
Erpobdellidae		13		-99
COLEOPTERA				
Berosus		1	8	17
Dubiraphia		2		6
Scirtes				8
Stenelmis				1
DECAPODA				
Orconectes virilis				-99
Palaemonetes kadiakensis			-99	1
DIPTERA				
Ablabesmyia			1	8
Ceratopogoninae		5		2
Chaoborus		1		
Clinotanypus		2		
Cricotopus bicinctus			1	
Cryptochironomus		1	1	
Cryptotendipes		6	1	
Dicrotendipes		1	29	4
Endochironomus			3	1
Glyptotendipes		1	39	15
Labrundinia				4
Muscidae			1	
Nanocladius		1	4	
Parachironomus				7
Paralauterborniella		3		
Polypedilum convictum grp			2	
Polypedilum illinoense grp		1	8	4
Polypedilum scalaenum grp			4	
Procladius		14		
Rheotanytarsus			5	4
Stictochironomus		1		
Tanypus		4		1
Tanytarsus		15	34	34
Thienemannimyia grp.			9	6
Tribelos			2	1
EPHEMEROPTERA				
Baetidae		1		
Caenis latipennis		5	1	1
Stenacron				3
HEMIPTERA				
Corixidae		4	2	
Mesovelia				1

ORDER: TAXA	CS	NF	SG	RM
Microvelia				1
Ranatra nigra				2
ISOPODA				
Lirceus			1	
LIMNOPHILA				
Ancylidae		3	4	
Helisoma		-99		
Menetus			1	4
Physella		1	-99	8
Planorbella		1		
LUMBRICULIDA				
Lumbriculidae		2		
ODONATA				
Argia			1	31
Arigomphus		-99		
Enallagma				5
Epitheca (Epicordulia)		2		3
Erythemis				1
Gomphus		-99		
Libellula				1
Macromia				-99
Nasiaeschna pentacantha			-99	
Pachydiplax longipennis				1
Plathemis		-99		
Somatochlora				1
RHYNCHOBDELLIDA				
Piscicolidae		1		
TRICHOPTERA				
Cheumatopsyche			30	5
Hydroptila			6	
Oecetis		2	2	
TRICLADIDA				
Planariidae		4	17	13
TUBIFICIDA				
Aulodrilus		1		
Branchiura sowerbyi		4		
Quistradrilus multisetosus		24	1	
Tubificidae		156	4	
VENEROIDEA				
Pisidium		1		
Sphaerium		20	13	17

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0318655], Station #2, Sample Date: 9/16/2003 4:00:00 PM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		11	1	13
AMPHIPODA				
Gammarus				6
Hyalella azteca		4	164	174
ARHYNCHOBDELLIDA				
Erpobdellidae		2	1	-99
COLEOPTERA				
Berosus		1	5	1
Dubiraphia			1	13
Hydroporus			1	
Peltodytes			2	
Scirtes				6
DECAPODA				
Palaemonetes kadiakensis		-99		-99
DIPTERA				
Ablabesmyia			6	1
Ceratopogoninae		22	3	2
Chaoborus		3		
Clinotanypus			2	
Cryptochironomus		1		
Cryptotendipes		15	1	
Culex				1
Dicrotendipes			22	
Diptera		1		
Einfeldia		1		
Glyptotendipes			20	
Labrundinia			3	2
Parachironomus				1
Paraphaenocladius			1	
Polypedilum halterale grp		1		
Polypedilum illinoense grp				4
Polypedilum scalaenum grp			2	
Procladius		10	2	
Tanypus		11		
Tanytarsus		9	33	6
Tribelos			5	
EPHEMEROPTERA				
Caenis punctata		9	28	30
Callibaetis		1	1	3
Hexagenia limbata		1		
Stenacron			1	
HEMIPTERA				
Belostoma				-99
Corixidae		19		
Neoplea				9
Steinovelia				1
LIMNOPHILA				
Ancylidae		1	4	
Helisoma				-99

ORDER: TAXA	**CS**	**NF**	**SG**	**RM**
Menetus			1	1
Physella			4	24
MEGALOPTERA				
Sialis		-99		
ODONATA				
Argia			7	35
Coenagrionidae				1
Enallagma		1	3	
Epitheca (Epicordulia)			-99	-99
Erythemis				4
Ischnura				5
Libellula			2	1
Nasiaeschna pentacantha			1	
Plathemis			-99	1
Somatochlora		-99		
TRICHOPTERA				
Cyrnellus fraternus			1	
Hydroptila			5	
Oecetis		1		3
TRICLADIDA				
Planariidae			2	6
TUBIFICIDA				
Aulodrilus		12	3	
Quistradrilus multisetosus		37		1
Tubificidae		132	4	
VENEROIDEA				
Sphaerium		2	6	2

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0318656], Station #3, Sample Date: 9/17/2003 9:40:00 AM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		3	9	
AMPHIPODA				
Hyalella azteca			4	91
ARHYNCHOBDELLIDA				
Erpobdellidae		2		
COLEOPTERA				
Dubiraphia				1
Hydrochus				1
Hydroporus				1
Scirtes			10	43
Tropisternus				-99
DECAPODA				
Palaemonetes kadiakensis			2	-99
DIPTERA				
Ablabesmyia			1	3
Aedes				2
Ceratopogoninae		92	2	6
Chironomus		1		
Clinotanypus		2		3
Cryptotendipes		1		
Dicrotendipes		1	71	14
Forcipomyiinae				3
Glyptotendipes		3	42	8
Kiefferulus		4	37	6
Labrundinia			1	4
Parachironomus				1
Polypedilum illinoense grp			1	6
Procladius		26	2	2
Tanypus		23	2	1
Tanytarsus		10	2	
Tribelos			1	1
EPHEMEROPTERA				
Caenis latipennis			3	3
Callibaetis		4	6	2
Stenacron		1	2	3
HEMIPTERA				
Belostoma				-99
Corixidae		2	11	
Mesovelia				1
Neoplea				10
Ranatra kirkaldyi				-99
Trepobates				1
ISOPODA				
Lirceus			1	
LEPIDOPTERA				
Pyralidae				1
LIMNOPHILA				
Ancylidae		1	22	3
Helisoma				1

ORDER: TAXA	CS	NF	SG	RM
Menetus				4
Physella			7	25
Planorbella			1	3
MEGALOPTERA				
Chauliodes rastricornis				2
Sialis		1		
ODONATA				
Argia			1	9
Ischnura				24
Libellulidae		1		2
Nasiaeschna pentacantha				2
Plathemis			-99	1
TRICHOPTERA				
Hydroptila		1		
TUBIFICIDA				
Aulodrilus		5		1
Branchiura sowerbyi		6		
Limnodrilus cervix		1		
Limnodrilus hoffmeisteri		2		
Quistradrilus multisetosus		36	11	
Tubificidae		45		2
VENEROIDEA				
Sphaerium		4	31	5

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0318717], Station #4, Sample Date: 9/17/2003 12:15:00 PM

ORDER: TAXA	**CS**	**NF**	**SG**	**RM**
"HYDRACARINA"				
Acarina		2		1
AMPHIPODA				
Hyalella azteca			77	14
COLEOPTERA				
Berosus			6	
Dubiraphia		1		6
Gyrinus			1	
Hydrochus			1	1
Scirtes			5	25
DECAPODA				
Palaemonetes kadiakensis			4	9
DIPTERA				
Ablabesmyia		1	2	
Anopheles				6
Ceratopogoninae		24	11	
Chaoborus		1		
Chironomus		2		
Cladopelma		5		
Clinotanypus		1	1	1
Cryptochironomus		3		
Cryptotendipes		6		
Culex				1
Dicrotendipes			19	6
Diptera				1
Endochironomus			5	1
Forcipomyiinae			27	1
Glyptotendipes			33	19
Kiefferulus			1	
Labrundinia			2	2
Larsia			2	
Microchironomus		5		
Parachironomus				11
Parakiefferiella			1	
Paralauterborniella		2		
Polypedilum halterale grp		6		
Polypedilum illinoense grp			7	8
Polypedilum scalaenum grp			1	
Procladius		16		2
Pseudochironomus			2	
Tanypus		4		
Tanytarsus		16	11	5
Thienemannimyia grp.			1	
Tribelos			5	5
EPHEMEROPTERA				
Baetidae			3	
Caenis punctata		13	13	9
Hexagenia limbata		3		
Stenacron			2	4
HEMIPTERA				

ORDER: TAXA	CS	NF	SG	RM
Corixidae		8	2	3
Mesovelia				1
Neoplea				5
Palmacorixa		2		
Rheumatobates			1	3
Steinovelia			1	
Trepobates				4
Trichocorixa				1
LIMNOPHILA				
Fossaria			1	3
Menetus			2	1
Physella			12	15
ODONATA				
Argia			5	38
Coenagrionidae				3
Enallagma			5	25
Ischnura				23
Libellulidae		1	2	
Nasiaeschna pentacantha			2	3
TRICHOPTERA				
Hydroptila			5	
Oecetis		2		
TRICLADIDA				
Planariidae			1	25
TUBIFICIDA				
Aulodrilus		4		
Branchiura sowerbyi		13		
Enchytraeidae			1	
Limnodrilus cervix		1		
Quistradrilus multisetosus		73	4	
Tubificidae		85	3	
VENEROIDEA				
Corbicula		3		
Pisidium		4		
Sphaeriidae		8	2	14

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0318718], Station #5, Sample Date: 9/17/2003 4:30:00 PM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		4	1	
AMPHIPODA				
Hyalella azteca				16
ARHYNCHOBDELLIDA				
Erpobdellidae		1		
COLEOPTERA				
Dubiraphia				3
Gyrinus				7
Hydrochus				3
Hydroporus		2		
Peltodytes			1	
Scirtes				56
DECAPODA				
Orconectes virilis		-99		-99
Palaemonetes kadiakensis		-99	1	2
DIPTERA				
Anopheles				3
Ceratopogoninae		26		
Chaoborus		1		
Chironomus		4	2	
Culex				1
Dicrotendipes		1	16	4
Forcipomyiinae			3	
Glyptotendipes		1	20	13
Kiefferulus		1	5	
Larsia			2	1
Nanocladius				1
Parachironomus				6
Polypedilum halterale grp			1	
Polypedilum illinoense grp		1	1	2
Procladius		1	1	
Tanypus		1		
Tanytarsus		2	12	
EPHEMEROPTERA				
Caenis latipennis			1	
Callibaetis		1	9	3
HEMIPTERA				
Belostoma				1
Corixidae		25	69	2
Gerridae				8
Neoplea				3
Ranatra fusca				-99
Trepobates				1
Trichocorixa			2	
LIMNOPHILA				
Ancylidae		2	1	
Fossaria				5
Helisoma		-99		2
Physella			4	27

ORDER: TAXA	CS	NF	SG	RM
MEGALOPTERA				
Sialis		1	1	
ODONATA				
Argia				3
Coenagrionidae			1	
Ischnura				1
Libellula			1	
Libellulidae		1		
Nasiaeschna pentacantha				-99
Plathemis			1	
Somatochlora		-99		1
TUBIFICIDA				
Aulodrilus			1	
Branchiura sowerbyi		6		
Quistradrilus multisetosus		184	12	2
Tubificidae		30		
VENEROIDEA				
Sphaerium		11	6	

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0418651], Station #1, Sample Date: 3/16/2004 11:30:00 AM

ORDER: TAXA	**CS**	**NF**	**SG**	**RM**
"HYDRACARINA"				
Acarina			1	2
AMPHIPODA				
Crangonyx				9
Hyalella azteca		2		23
ARHYNCHOBDELLIDA				
Erpobdellidae		-99		
COLEOPTERA				
Berosus			1	1
Hydroporus		3		
Scirtes				2
DECAPODA				
Orconectes immunis				1
Palaemonetes kadiakensis				4
DIPTERA				
Ceratopogoninae		29		
Chaoborus		4		
Chironomus		1		
Cladotanytarsus		1		
Cnephia				3
Corynoneura		1	4	
Cricotopus/Orthocladius		2	42	12
Culicidae		1		1
Dicrotendipes		2	9	
Diptera		1		
Ephydridae		1		
Glyptotendipes		2	16	1
Gonomyia				1
Hydrobaenus		9	16	8
Ormosia		1		
Paraphaenocladius				1
Polypedilum convictum grp		1	2	
Polypedilum halterale grp		4		
Polypedilum illinoense grp			35	9
Procladius		15		
Simulium			4	2
Smittia				1
Tanytarsus		20	8	3
Thienemanniella			5	2
Thienemannimyia grp.				1
Tribelos		1		
EPHEMEROPTERA				
Ameletus				5
Caenis latipennis		5	1	1
Hexagenia limbata		1		
Stenacron			1	
HEMIPTERA				
Trichocorixa		1		
ISOPODA				
Lirceus			2	3

ORDER: TAXA	CS	NF	SG	RM
LIMNOPHILA				
Fossaria			1	1
Physella		-99	2	1
ODONATA				
Gomphus		1		
Nasiaeschna pentacantha			1	
RHYNCHOBDELLIDA				
Glossiphoniidae			1	
TRICHOPTERA				
Ironoquia			1	
TRICLADIDA				
Planariidae		1		1
TUBIFICIDA				
Aulodrilus		1		
Branchiura sowerbyi		3		
Enchytraeidae		22	15	4
Limnodrilus cervix		4		
Limnodrilus claparedianus		1		
Limnodrilus hoffmeisteri		19	5	
Quistradrilus multisetosus		2		
Tubificidae		99	12	
VENEROIDEA				
Pisidium		4		
Sphaerium		21	2	

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0418652], Station #2, Sample Date: 3/16/2004 3:00:00 PM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		5		
AMPHIPODA				
Crangonyx		8	2	75
Hyalella azteca		24	43	119
COLEOPTERA				
Berosus				1
Dineutus				-99
Gyretes				1
Hydrochara			1	
Hydroporus		3		3
Paracymus				1
Peltodytes			1	
Scirtes			1	1
DECAPODA				
Orconectes immunis		1		
Palaemonetes kadiakensis		3		2
DIPTERA				
Ceratopogoninae		4		
Cladotanytarsus		1		
Cnephia			2	
Corynoneura			2	1
Cricotopus/Orthocladius		7	18	5
Dicrotendipes		2	1	
Diptera		3	2	1
Glyptotendipes			5	
Hydrobaenus		32	45	6
Ormosia		1		
Paraphaenocladius				3
Paratanytarsus		2		
Polypedilum halterale grp		1		
Polypedilum illinoense grp		2	10	16
Procladius		10		
Simulium			3	
Tabanus		2		
Tanytarsus		22	1	
Thienemanniella			1	
Tipula				3
Tipulidae			1	
Tribelos		1		
EPHEMEROPTERA				
Ameletus lineatus			2	2
Caenis latipennis		38		6
Stenacron			2	
HEMIPTERA				
Ranatra nigra		-99		
Trichocorixa		1		
ISOPODA				
Lirceus		1	1	1
LIMNOPHILA				

ORDER: TAXA	CS	NF	SG	RM
Fossaria			1	2
Physella		-99	3	5
ODONATA				
Argia				1
Enallagma		-99		1
Ischnura				1
Libellula		3		1
Nasiaeschna pentacantha			2	1
TRICHOPTERA				
Cheumatopsyche		1		
Ironoquia			2	1
Oecetis		1		
TRICLADIDA				
Planariidae		1		
TUBIFICIDA				
Branchiura sowerbyi		1		
Enchytraeidae		49		9
Limnodrilus cervix		1		
Limnodrilus claparedianus		2		
Limnodrilus hoffmeisteri		27		1
Tubificidae		50		3
VENEROIDEA				
Sphaerium		8		2

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0418653], Station #3, Sample Date: 3/16/2004 4:30:00 PM

ORDER: TAXA	CS	NF	SG	RM
AMPHIPODA				
Crangonyx				2
Hyalella azteca		5	1	16
ARHYNCHOBDELLIDA				
Erpobdellidae		1		
COLEOPTERA				
Dineutus				3
Hydroporus		1		6
Peltodytes				2
Scirtes				18
DECAPODA				
Orconectes immunis		-99		1
Orconectes virilis		-99		
Palaemonetes kadiakensis		3		3
DIPTERA				
Ceratopogoninae				1
Chaoborus				1
Cnephia			47	2
Cricotopus/Orthocladius		17	42	20
Dicrotendipes		1	11	1
Eukiefferiella			2	1
Glyptotendipes		2	2	2
Hydrobaenus		25	18	29
Kiefferulus			4	1
Paraphaenocladius		1	2	4
Polypedilum illinoense grp		3		
Procladius		31		
Simulium		19	184	11
Tabanus		2		
Tanypus		1		
Tanytarsus		2		
Tipulidae		2		
EPHEMEROPTERA				
Ameletus				2
Caenis latipennis		1		1
HEMIPTERA				
Notonecta				1
Palmacorixa		1		
Trichocorixa		3		2
ISOPODA				
Lirceus				3
LIMNOPHILA				
Ancylidae				1
Menetus				1
Physella		3	8	15
Planorbella				1
LUMBRICINA				
Lumbricidae		1		
MEGALOPTERA				
Chauliodes rastricornis				1

ORDER: TAXA	CS	NF	SG	RM
Sialis		7		
ODONATA				
Enallagma		-99		
Ischnura				4
Perithemis		1		
Plathemis		-99		
RHYNCHOBDELLIDA				
Glossiphoniidae				1
TRICHOPTERA				
Ironoquia				1
TUBIFICIDA				
Enchytraeidae		9		6
Limnodrilus cervix		3		
Limnodrilus claparedianus		5		
Limnodrilus hoffmeisteri		10		1
Quistradrilus multisetosus		18		1
Tubificidae		123	1	6
VENEROIDEA				
Sphaerium		12		1

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0418654], Station #4, Sample Date: 3/17/2004 10:15:00 AM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		5		1
AMPHIPODA				
Hyalella azteca		10	3	27
ARHYNCHOBDELLIDA				
Erpobdellidae		1		1
COLEOPTERA				
Dineutus			1	1
Gyrinus				1
Hydroporus				2
Laccophilus				1
Scirtes		1		
DECAPODA				
Palaemonetes kadiakensis		-99		7
DIPTERA				
Bryophaenocladius		1		
Ceratopogoninae		5		1
Chironomus		2		3
Cladotanytarsus		1		
Cnephia			1	1
Cricotopus/Orthocladius		27	34	21
Dicrotendipes		1	3	1
Diptera		2		1
Dolichopodidae		4		
Eukiefferiella			1	
Glyptotendipes			8	
Hydrobaenus		71	1	32
Kiefferulus		1		1
Limnophila				1
Nanocladius		1		
Ormosia		2		1
Paraphaenocladius		2		4
Polypedilum illinoense grp		5		23
Procladius		3		
Simulium		1	2	3
Smittia		2	1	1
Stratiomys			-99	
Tabanus				1
Tanytarsus		1		
Tribelos		3	2	2
EPHEMEROPTERA				
Caenis latipennis		17		1
Callibaetis				1
Stenacron				1
HEMIPTERA				
Palmacorixa				1
Trichocorixa		8		1
ISOPODA				
Lirceus				1
LIMNOPHILA				

ORDER: TAXA	CS	NF	SG	RM
Fossaria		6	1	3
Menetus				1
Physella		4		5
Planorbella			1	1
ODONATA				
Enallagma		1		
Epitheca (Epicordulia)		1		
Gomphus		1		
Ischnura		2		1
Nasiaeschna pentacantha				1
Pachydiplax longipennis				1
Perithemis		1		
Plathemis		1		
TRICHOPTERA				
Cyrnellus fraternus			1	
Oecetis		1		
TUBIFICIDA				
Enchytraeidae		18		6
Limnodrilus hoffmeisteri		1		
Tubificidae		9		5
VENEROIDEA				
Sphaerium		3		5

Aquid Invertebrate Database Bench Sheet Report
Miami Ck [0418655], Station #5, Sample Date: 3/17/2004 12:30:00 PM

ORDER: TAXA	CS	NF	SG	RM
N/A				
Branchiobdellida		1		
"HYDRACARINA"				
Acarina		1		
AMPHIPODA				
Crangonyx				1
Hyalella azteca		5		24
ARHYNCHOBDELLIDA				
Erpobdellidae		-99		
COLEOPTERA				
Dineutus				1
Hydroporus		3	1	3
Scirtes			1	
DECAPODA				
Orconectes virilis		-99		
Palaemonetes kadiakensis		-99		5
DIPTERA				
Ceratopogoninae		2		1
Chaoborus		1		
Clinocera			1	
Clinotanypus		1		
Cnephia			7	
Cricotopus/Orthocladius		1	99	7
Cryptochironomus		2		
Dicrotendipes			8	
Ephydridae		1		
Eukiefferiella			3	1
Glyptotendipes			2	
Hydrobaenus		11	49	8
Kiefferulus			1	
Limnophyes				1
Ormosia				1
Paraphaenocladius			1	5
Paratendipes		11		
Polypedilum halterale grp		1		
Polypedilum illinoense grp		1		1
Procladius		43		1
Pseudosmittia			6	
Simulium		1	53	
Smittia			2	
Tanytarsus		2	1	
Tvetenia			2	
EPHEMEROPTERA				
Caenis latipennis		3		
Hexagenia limbata		2		
HEMIPTERA				
Trichocorixa		6		
ISOPODA				
Lirceus			2	11
LIMNOPHILA				

ORDER: TAXA	CS	NF	SG	RM
Fossaria				2
Physella		1	5	5
MEGALOPTERA				
Sialis		-99		
ODONATA				
Ischnura		1		1
Nasiaeschna pentacantha				-99
PLECOPTERA				
Allocapnia			1	
TRICHOPTERA				
Ironoquia			1	
Rhyacophila			1	
TUBIFICIDA				
Branchiura sowerbyi		4		
Enchytraeidae		7	13	1
Limnodrilus claparedianus		2		
Limnodrilus hoffmeisteri		5		
Quistradrilus multisetosus		20		1
Tubificidae		131	1	
VENEROIDEA				
Sphaerium		7	4	

CS = Coarse substrate Habitat
NF = Nonflow Habitat
SG = Snag (i.e., Large Woody Debris Habitat)
-99 = Present in Samples